

48.
Kelvin's
available
energy.

available energy as distinguished from total energy had been introduced by Lord Kelvin and by Maxwell. This free energy is measured not only by the heat liberated, but depends on all the other factors, such as volume and pressure, the number of chemical substances engaged, and their physical conditions. The doctrine of energy and the conception of free energy pointed out a method of co-ordinating all these different factors and reducing them to a common measure. As Rankine, by the introduction of the term potential energy, did much to clear the ideas and guide the reasoning in dynamical science, so Helmholtz, by introducing the term free energy, did a great deal to introduce into chemical science the fruitful conceptions which had been elaborated and applied in physical research. The term free or available energy seems to describe more naturally the characteristic property of all energy which is useful for doing work, whilst the opposite term entropy—which measures the unavailable or hidden energy—refers to a quantity for which we have no immediate means of perception.¹

ance of these somewhat abstruse expositions lies mainly in two directions: First, in the recognition of the fact that for the correct description of natural phenomena and changes the knowledge of the total energy is as little sufficient as that of the total weight or mass, but that it is necessary to introduce the conception of useful energy, of energy which is free or available for doing work; secondly, in the recognition that the course of chemical changes or reactions cannot be measured by attending to one special property, such as weight, or temperature, or entropy, but that it requires the

measurement of a quantity which comprises all the different agencies in nature, this quantity being the energy of the system or substances in question and its availability. A third point, which is of more or less importance according to the general view adopted, is this, that the mathematical formulæ involved have exhibited the analogy between chemical and mechanical processes, the latter being those which were earliest and are most easily grasped by the mind.

¹ As Prof. Ostwald has remarked, it is to a great extent a matter of taste what particular form one adopts out of the many in which the